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standard base map of Canada on the scale of 1:2,217,600 published by the Department of the Interior, Ottawa.

Such maps as Captain Comer's, although tentative, are of great value for regions not adequately surveyed. Until superseded by systematic surveys they represent the only material available. Not their least merit is, precisely because of their preliminary nature, to call attention to the necessity for adequate surveys, all the more urgent in the region under consideration in view of the probable establishment of the Hudson Bay-Liverpool route as an outlet for the wheat crop of western Canada.

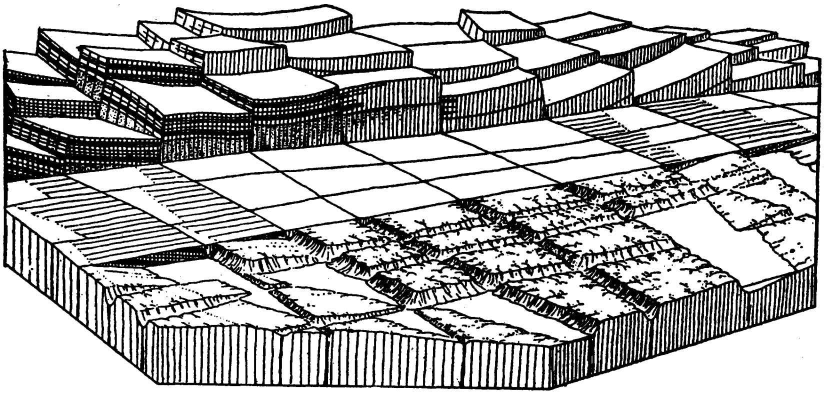
NOTES ON THE DESCRIPTION OF LAND FORMS.—X

Fault-line Scarps in Central Sweden.

Explanation of Map of Land-forms in the Surroundings of the Great Swedish Lakes. By S. de Geer. *Sveriges Geol. Undersök.*, Ser. Ba, No. 7, 1910. 30 pp.

Über die Beziehung zwischen Geologie und Landschaftsformen in Mittelschweden. Führer einer morphologischen Exkursion. By O. Nordenskjöld und S. de Geer. XI Internat. Geologkongressen, Stockholm, 1910.

There is a district of curious form in central Sweden, which is roughly represented in the foreground section of the accompanying diagram (looking northwest), taken from the writer's "Erklärende Beschreibung der Landformen." The district may be empirically described as possessing a central upland of crystalline rocks, having an equable altitude and being divided into irregular lozenge-shaped masses (of too uniform pattern in the diagram) by a series of narrow, criss-cross valleys, and being bordered on the north and south by broad depressions holding lakes, to which the uplands descend by rather abrupt escarpments of more or less zigzag pattern. The lacustrine areas possess here and there small patches of nearly horizontal limestones, which lie on an even floor of crystalline rocks, and this floor rises slowly north and south from the depressions, and thus again forms uplands of lozenge-shaped masses divided by narrow criss-cross valleys.



Development of Fault-line Scarps and Valleys in Central Sweden.

If the same district were described in explanatory fashion, the description would vary according to the explanation adopted, but all explanations agree that the district has been glaciated. If we follow the Swedish authors above cited, or the earlier writer, G. Andersson (Om Mälartrakternas geografi, *Ymer,* 1903, 1–64), the district may be described as composed of disordered crystalline rocks, that were long ago reduced to a peneplain, or to a marine platform, then covered unconformably by a series of ancient stratified deposits, uplifted, and exposed to erosion so long that nearly all the underlying peneplain was laid bare and only small patches of the stratified cover remained; then recently divided by many criss-cross faults into lozenge-shaped blocks, of which the depressed members, slanting very gently from the north and south towards a central area, are now partly covered by lakes, while the uplifted higher central area is subdivided by narrow valleys that have been eroded along the shattered zone of the criss-cross faults. According to this explanation, the ancient plain of erosion is seen in the central uplands, stripped of its cover and somewhat the worse for wear; the bordering zigzag fault scarps on the north and south are so recent that they are little affected by erosion; and the neighboring depressions, holding lakes, are essentially due to the down-faulting of parts of the stripped peneplain.

If we follow another explanation, the compound mass, consisting as before of ancient horizontal strata lying unconformably on a smoothly truncated crystalline foundation, was long ago jostled on many criss-cross faults, whereby an uneven surface was produced; the neighboring blocks were thus divided by fault scarps, as in the background of the above diagram; then the district was baselevelled, as in the central part of the diagram, large patches of the covering strata being retained in certain blocks that were gently inclined to a lower level than their neighbors. Later came a broad uplift without faulting, and in the cycle of erosion thus introduced and still current, many narrow fault-line valleys have been eroded along the shattered zone of the faults in the area of the resistant crystallines, and broad lowlands have been excavated, partly by aid of glacial erosion, in the large patches of covering strata, whereby they are reduced to small patches, limited for the most part to the lower parts—the "safe corners"—of their depressed blocks. According to this explanation, the lacustrine depressions have been excavated in the weaker parts of an uplifted peneplain; that is, they are wholly due to erosion on the weaker area of a peneplain worn down on a compound mass of faulted structure, and not to faulting; the central uplands are limited to north and south by resequent fault-line scarps, not produced by faulting but by differential erosion on a faulted structure of unequal resistance; and the equable altitude of the central uplands is not an inheritance of the earliest planation of the region that took place before the deposition of the covering strata, and hence all the longer before the faulting; but is the result of peneplanation after the faulting of the region, and hence all the longer after the deposition of the covering strata.

There are two reasons for preferring the second explanation. First, the numerous lozenge-shaped blocks of the central uplands preserve an even skyline and an equable altitude across the many fault-line valleys by which they are now divided; and this strongly suggests that their upland surface, before its present submature dissection and glaciation, was due to peneplanation after faulting; hence it is of much later origin than the ancient peneplain on which the covering strata were deposited. Second, the small patches of covering strata now survive only in the depressions (the larger and higher patches farther southwest, covered by ancient lava sheets, are not here in question), as if their preservation were due to their lowly altitude at the time when their former larger patches were reduced; and this strongly suggests that the widespread erosion which swept away most of the covering strata took place after the faulting. Had it taken place before, the existing residual patches of the covering strata ought not to have a specialized distribution with respect to the depressed blocks, in the "safe corners" of which the patches actually do occur.

The full establishment of either of the above explanations demands further field work; but the adoption of the first explanation by the Swedish observers, without consideration of the second, necessarily leaves their conclusion open to question. It may be fairly urged that the possession by an investigator of an elaborated scheme of surface forms developed on faulted structures, including fault-line valleys and fault-line scarps produced by the erosion of a faulted mass, as well as fault valleys and fault scarps produced directly by faulting, reacts advantageously in field work by requiring a discrimination between various classes of forms which, under a less complete scheme, would not be distinguished.

This example is one of the many in which the study of surface forms contributes to the deciphering of geological history. According to the first explanation, sketched above, the district concerned has been peneplained only once, namely, before the deposition of the covering strata; and the date of its faulting is so recent that the fault scarps are still pronounced topographic features. The measure of faulting on the north- and south-facing escarpments of the central district is, according to this explanation, closely measured by the height of the scarps, plus the depth of the lakes, plus the thickness of covering strata beneath the lakes; while the faulting on the lines of the criss-cross valleys in the central district must have been chiefly a rubbing up and down with resulting brecciation of the adjoining rocks, so that valleys should afterwards be easily excavated along the fault-line; but there could have been no significant differential displacement here, because the neighboring lozenge-shaped areas are of equable altitude, and because their surface is not diversely tilted, as the ancient peneplain is where it descends gently into the lacustrine depressions.

According to the second explanation, the district has been twice peneplained; first before the deposition of the covering strata, and second after the faulting of the compound mass, as indicated in the background and middle section of the above diagram. The second peneplanation, delicately truncating the faulted blocks somewhat above or below the dislocated parts of the earlier peneplain, is, according to this explanation, responsible for the evenness of the central uplands, as well as for the erosion of the greater part of the covering strata from over the whole area region; while the removal of nearly all the remaining parts of the covering strata has been accomplished in the new cycle of erosion after the broad uplift which followed the second peneplanation; and with the progress of this removal the earlier peneplain has been laid bare in the gently slanting surface of the depressed blocks, the small patches of the covering strata now preserved being naturally limited to the "safe corners" of the deepest depressions near the fault-line scarp. The occurrence of two peneplains, a later one intersecting an earlier one at a small angle, is evidently a possibility, and is actually no rarity, though it has often been overlooked in many districts where it may be demonstrated by close study. Further, the measure of faulting on the north- and south-facing escarpments must have exceeded the measure given above by the depth of the newer peneplain beneath the older one along the margins of the central district; and the measure of faulting on the criss-cross faults of the central uplands, instead of having been insignificant, may have had any significant value. Again, the date of the faulting may be ancient instead of recent; it may have been soon after the deposition of the covering strata, and it may have been followed by several cycles of erosion, of which only a late one is recorded in the peneplanation of the uplands: but the faulting must have been at least remote enough to allow the faulted surface to be peneplained, broadly uplifted, and then submaturely dissected even in its harder parts.

Explanatory description is sometimes objected to on account of its danger of possible error; and in the account of these Swedish escarpments we have a good example against which to direct such objection. Both of the above explanations are current, but both cannot be true. The probability of correctness is, however, in favor of the one that has been adopted after a fair consideration of both; namely, the second. This explanation first came to my attention through a study of the large-scale Swedish maps (sheets 55, 56, 65, 66, 73, 74) of this interesting district, and was confirmed by a two-day excursion across the district fourteen years ago.

Newfoundland Once a Peneplain.

PHYSIOGRAPHY OF NEWFOUNDLAND. By W. H. Twenhofel. *Amer. Journ. of Sci.*, xxxiii, No. 1, 1912, pp. 1–24.

The order of statement in this paper is to be commended, because the needs of the reader are duly considered. After an introductory paragraph, the author briefly states his main conclusion, namely, that "the uplands of Newfoundland are the remnants left by dissection of a once almost perfect peneplain"; then follow several pages giving descriptions of structure and topographic features—these for the most part treated empirically—and of the effects of uplift, submergence and glaciation; finally a few pages are given demonstrating the origin of the surface features. As a result of this arrangement the paper is easily read and quickly understood. The preliminary statement of results, quoted above, might have been somewhat expanded to advantage; the intermediate pages, not being purely empirical, might well have been more fully explanatory. It savors of artificial restraint to describe the general form of the uplands, their prevailing decrease of altitude to the southeast about 10 feet to a mile, and the presence of numerous surmounting summits only in empirical terms; the reader will recognize the area as an uplifted and dissected peneplain, and will wonder why the writer avoids describing it as such. It is hardly worth while in this modern day to separate by several pages the description of branching bays and the explanation of their origin by submergence. But in the main the order of presentation is worthy of imitation, because of the aid that it gives to the reader; and as the readers of the article are a hundred or a thousand times more numerous than the author, he was well advised in constructing the paper with due regard to their convenience.

A striking feature of the island is an abrupt scarp along the almost rectilinear western border of the uplands where they reach a highland altitude of 1500 or 2000 feet. When viewed from the sea, the highland and its scarp look like an even-crested range of mountains, and probably for this reason the highland border belt is called the Long Range. It is composed of crystalline rocks, while the low foreland along its base consists of sedimentary rocks. Here the commendable order—conclusion, detail, explanation—is not followed; the origin of the scarp is not stated until twelve pages after its empirical description. The scarp is then explained as a fault-face, and the low foreland along its base is thought to have once been continuous with the peneplain of the uplands, the two parts having been since then separated by faulting. This is curiously enough a close repetition of the conclusion reached regarding the scarps of central Sweden, by Swedish observers, discussed in the preceding note; and as in the Swedish example, so here, no consideration is given to the alternative possibility that the scarp is due to differential erosion on a faulted structure, and not to faulting. If the scarp be really due to faulting, then a relatively late date must be given to this dislocation in Newfoundland, and the vertical displacement must have equaled the height of the scarp; but if the scarp be due to erosion on a faulted structure, then the date of the faulting may be placed anywhere between the making of the faulted rocks and the completion of the peneplain now elevated in the gently slanting uplands; and the vertical displacement must have been the height of the scarp, plus the thickness of the strata below its base, plus the thickness of the crystalline rocks eroded from above the present crest of Long Range. Hence, as above noted, geologists as well as geographers may well take heed of the problem here involved. W. M. Davis.